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SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the fiscal year ended December 31, 2003

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934 [NO FEE REQUIRED]**

For the transition period from _____ to _____

Commission file number 000-13059

CERADYNE, INC.

(Exact name of registrant as specified in its charter)

Delaware	**33-0055414**
(State or other jurisdiction of Incorporation or organization)	**(I.R.S. Employer Identification No.)**
3169 Red Hill Avenue, Costa Mesa, California	**92626**
(Address of principal executive offices)	**(Zip Code)**

(714) 549-0421
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act: None

Securities registered pursuant to Section 12(g) of the Act: Common Stock, par value $.01 per share

Indicate, by check mark, whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports); and (2) has been subject to such filing requirements for the past 90 days. YES ☒ NO ☐

Indicate, by check mark, if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

Indicate by check mark whether the registrant is an accelerated filer (as defined in Securities Exchange Act Rule 12b-2). YES ☒ NO ☐

As of February 20, 2004, the aggregate market value of the Common Stock held by non-affiliates was approximately $335,335,414.

As of February 20, 2004, there were 10,626,669 shares of registrant's Common Stock outstanding.

DOCUMENTS INCORPORATED BY REFERENCE: None

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PART I

FORWARD-LOOKING STATEMENTS

This annual report on Form 10-K contains forward-looking statements including statements concerning the future of our industry, product development, business strategy, continued acceptance of our products, market growth, and dependence on significant customers. These statements can be identified by the use of forward-looking terminology such as “may,” “will,” “expect,” “anticipate,” “estimate,” “continue,” or other similar words. When considering forward-looking statements, you should keep in mind the risk factors and other cautionary statements in this report, including, in particular, those discussed in the sections entitled “Risk Factors” and “Management’s Discussion and Analysis of Financial Condition and Results of Operations.” The risk factors and other factors noted throughout this report could cause our actual results to differ significantly from those contained in any forward-looking statement. Except as required by law, we undertake no obligation to update publicly any forward-looking statements contained in this report to conform these statements to actual results or to changes in our expectations.

ITEM 1. Business

Introduction

We develop, manufacture and market advanced technical ceramic products and components for defense, industrial, automotive/diesel and commercial applications. Our competitive advantage results from our expertise in ceramic material science as well as our vertically integrated approach of designing much of our key equipment and controlling the manufacturing process from raw material powders to finished product. This allows us to design and manufacture precision, high quality advanced technical ceramic products to meet demanding customer specifications. Our customers include the U.S. government, prime government contractors and large industrial and commercial manufacturers.

In many high performance applications, products made of advanced technical ceramics meet specifications that similar products made of metals, plastics or traditional ceramics cannot achieve. Advanced technical ceramics can withstand extremely high temperatures, combine hardness with light weight, are highly resistant to corrosion and wear, and often have excellent electrical insulation capabilities, special electronic properties and low friction characteristics.

Our primary products include:

- lightweight ceramic armor for soldiers and military helicopters;
- aesthetic ceramic orthodontic brackets;
- durable, reduced friction, ceramic diesel engine components;
- ceramic-impregnated dispenser cathodes for microwave tubes, lasers and cathode ray tubes; and
- ceramic industrial components for erosion and corrosion resistant applications.

The principal factor contributing to our recent growth in sales is increased demand by the U.S. military for ceramic body armor that protects soldiers. The ongoing adoption of ceramic body armor by the military is driven by a growing recognition of the technical advancement of materials available and the life saving benefits of lightweight ceramic body armor. Recent military conflicts in Afghanistan and Iraq, as well as an increasingly unstable geopolitical climate and the heightened risk of international conflicts, have resulted in increased orders for these products. Ceramic armor contracts generally are awarded in an open competitive bidding process. Our future level of sales of ceramic body armor will depend on our ability to successfully compete for this business.

We have also developed other products that could have a significant impact on our long-term growth, including:

- missile radomes (nose cones) for the defense industry;
- ceramic crucibles used for melting silicon in the photovoltaic solar cell manufacturing process;
- corrosion resistant ceramic components sold to semiconductor equipment manufacturers; and
- lightweight ceramic armor for incorporation into civilian and military vehicles.

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To meet increasingly higher performance standards, advanced technical ceramics have stringent technical manufacturing requirements. We have designed and customized our facilities and capital equipment to enhance our advanced technical ceramic manufacturing processes. We recently implemented lean manufacturing initiatives to lower costs and achieve further efficiencies in our manufacturing processes, and are expanding our facilities to add manufacturing capacity.

Our goal is to profitably develop, manufacture and sell advanced technical ceramic components to customers and markets where there is a need for new materials that will increase the efficiency, productivity and life of our customers' end products. Key elements of our strategy for achieving this goal include:

- capitalizing on opportunities in the defense market;
- investing to improve our gross margins and manufacturing efficiencies;
- identifying new products and markets;
- continuing to diversify our non-defense revenue base;
- leveraging our facilities and technologies to address new products and markets; and
- increasing our international sales.

We conduct our operations primarily from our three domestic manufacturing locations. Our principal executive offices are located at 3169 Red Hill Avenue, Costa Mesa, California 92626, and our telephone number is (714) 549-0421. We maintain a web site at www.ceradyne.com. The reference to our web site address does not constitute incorporation by reference into this report of the information contained at that site. We are organized as a Delaware corporation.

Industry Background

Evolving customer requirements in industrial processing, military systems, microwave electronics, automotive/diesel engine products and orthodontics have generated a demand for high performance materials with properties not readily available in metals, plastics or traditional ceramics. In some high performance applications, this demand has been met by products made of advanced technical ceramics.

The following table compares favorable typical properties of selected advanced technical ceramics with those of other selected materials.

MATERIALS	MELTING POINT (DEGREES FAHRENHEIT)	HARDNESS (VICKERS SCALE)	CHEMICAL RESISTANCE TO ACIDS	ELECTRICAL PROPERTIES	DENSITY (GRAMS PER CUBIC CENTIMETER)
Advanced technical ceramics	2,500 to 6,900	Up to 3,200	Excellent	From conductors to excellent insulators	2.5 to 4.5
High strength alloy steel	2,500 to 2,700	Up to 900	Fair	Conductors	7.0 to 9.0
High performance plastics	275 to 750	Up to 10	Good to Excellent	Good to excellent insulators	1.0 to 2.0

Ceramics such as earthenware, glass, brick and tile have been made for centuries and are still in common use today. The inertness and lasting qualities of ceramics are illustrated by artifacts uncovered intact in modern times. Almost all traditional ceramics, including those of ancient times, were based on clay. In the last fifty years, significant advances have been made in ceramic technology by applying specialized manufacturing processes to produce synthetic ceramic powders. Developments in aluminum oxide and other oxides provided ceramics that are excellent electrical insulators and are capable of withstanding high temperatures. In addition, industry advancements in ceramic material science have led to the development of a class of ceramics that are generally non-oxides, such as carbides, borides and nitrides. These materials generally have mechanical properties that exceed those of oxide ceramics developed in prior periods. Collectively, these developments resulted in the ability to manufacture ceramics with great strength at elevated

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temperatures and reduced brittleness, historically a primary limitation of ceramics. The products that have emerged from these advances are known as advanced technical (or structural) ceramics.

The properties of advanced technical ceramics present a compelling case for their use in a wide array of modern applications. However, to meet increasingly higher performance standards, advanced technical ceramics have stringent technical manufacturing requirements. The specialized equipment required to manufacture advanced technical ceramics must often be custom designed and is not readily available, requiring a significant investment in capital equipment and facilities to allow volume production. Manufacturing costs associated with the production of these materials are generally higher than the materials they replace. A portion of these costs is related to the need for diamond grinding finished components to exacting tolerances. To accelerate the use of advanced technical ceramics as a direct replacement for metals, plastics or other ceramics, these manufacturing costs need to be reduced. Cost reduction efforts include the production of blanks or feed stock to “near net shape” configurations in order to reduce the amount of diamond grinding needed. Manufacturers are also seeking to reduce costs through the use of high volume automated processing and finishing equipment and techniques, and to achieve economies of scale in areas such as powder processing, blank fabrication, firing, finishing and inspection.

Our Solution

We develop, manufacture and market advanced technical ceramic products and components for defense, industrial, automotive/diesel and commercial applications. Our competitive advantage results from our expertise in ceramic material science as well as our vertically integrated approach of designing much of our key equipment and controlling the manufacturing process from raw material powders to finished product. This allows us to design and manufacture precision, high quality advanced technical ceramic products to meet demanding customer specifications.

The following table illustrates some of the solutions we have designed to meet market opportunities and demands.

MARKET OPPORTUNITY	DEMANDS OF THE MARKET	OUR SOLUTION
	DEFENSE	
Lightweight ceramic body armor	Due to the proliferation of automatic weapons in tactical operations and terrorist conflicts, it has become necessary to stop bullets as large as .50 caliber machine gun rounds. However, vests or other armor must be light enough in weight to allow freedom of movement without undue fatigue.	We have developed lightweight bullet resistant ceramic body armor solutions, including small arms protective inserts (SAPI) and other systems. These products generally consist of hot pressed Ceralloy® 546 (boron carbide) or hot pressed Ceralloy® 146 (silicon carbide) ceramic coupled with backings such as Kevlar™ or Spectra Shield™.
Lightweight ceramic armor for military aircraft and ground and sea-based vehicles	Military aircraft, ground-based vehicles and boats require protection against automatic weapons. Weight, cost and vehicle compatibility are critical technical parameters.	We have developed a series of lightweight, cost effective ceramic armor systems and attachment mechanisms that have multi-hit protection at various threat levels and can be added to an existing vehicle or designed into new military vehicles and aircraft.
Missile radomes (nose cones)	Defensive tactical missile systems such as the PAC-3 (Patriot Advanced Capability), Arrow Missile and the Standard Missile Block IV are designed to fly at extremely high velocities, survive tight turning radii and operate in severe weather conditions. These operating conditions preclude the use of conventional polymer materials for radomes.	We have developed advanced technical ceramic radomes made of fused silica ceramics which meet certain specifications of these tactical defensive missile systems, and we are developing a modified silicon nitride radome for more demanding requirements. We have also established a precision diamond grinding capability to finish these radomes.
	INDUSTRIAL	
Semiconductor equipment	The industry has historically used silicon	We supply high density and high purity

components for applications in processing chambers	metal, quartz, and aluminum oxide ceramics to fabricate processing chamber components. Semiconductor equipment manufacturers increasingly require processing chamber components that are longer lasting and result in lower particulate contamination.	nitride and carbide ceramic components to semiconductor wafer processing equipment companies. Our R&D group is working with semiconductor equipment suppliers to tailor our ceramic materials to meet new equipment requirements.
Industrial equipment requiring critical protection against severe wear or corrosion	Failure of industrial equipment is often caused by premature wearing out of surfaces due to abrasive action. An example is paper making equipment where the pulp slurry runs at 5,000 feet per minute.	Ceralloy® 147 Sintered Reaction Bonded Silicon Nitride (SRBSN) industrial wear parts and cutting tool inserts are designed to replace hard metal or even oxide ceramic wear surfaces, resulting in greater productivity, quality and longer uptime.
Photovoltaic (solar cell) manufacturing requiring crucibles for melting silicon	In order to produce cost effective solar cell components, it is necessary to melt silicon in a crucible or vessel that will be able to contain the molten silicon yet not allow unwanted chemicals to contaminate the melt.	We have developed a high purity fused silica ceramic crucible (receptacle) which is being used by several photovoltaic cell manufacturers in their silicon melting operation. We are currently expanding our fused silica ceramic crucible production facility.

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MARKET OPPORTUNITY	DEMANDS OF THE MARKET	OUR SOLUTION
	AUTOMOTIVE/DIESEL	
Heavy-duty diesel truck engines	In order to achieve diesel engine life of 500,000 miles or more without major maintenance, and to meet current environmental requirements, it may be necessary to replace metal engine components with longer lasting, lighter weight, lower friction ceramic parts at acceptable unit costs.	Our Ceralloy® 147 SRBSN engine components have been developed in order to allow diesel engines to run at higher internal pressures and thus meet environmental and other requirements. We continue prototype development with a number of engine and fuel systems manufacturers worldwide to expand the application of our diesel engine products.
Armored civilian vehicles	When constructing automobiles or limousines with ballistic protection for non-military applications, it is necessary to keep added weight to a minimum in order to achieve reasonable gas consumption and have car components, such as doors, open and close with relative ease.	Using our lightweight ceramic armor developed for military applications, we have adapted the shapes to certain civilian applications such as the Ford Motor Company Lincoln Town Car Ballistic Protection Series.
	COMMERCIAL	
Orthodontic brackets	Traditional stainless steel orthodontic brackets are often considered unsightly. Substitute clear plastic materials can be weak and may stain. Some orthodontic patients prefer aesthetically pleasing brackets which can be affixed to each tooth to support the arch wire.	Our Transtar® translucent orthodontic brackets are inert, reveal the color of the patient's teeth, and allow the orthodontist to correct the patient's bite. Our marketing partner, 3M Unitek, sells this aesthetic ceramic bracket under the brand name Clarity™.

Our Business Strategy

Our goal is to profitably develop, manufacture and sell advanced technical ceramic components to customers and markets where there is a need for new materials that will increase the efficiency, productivity and life of our customers' end products. Key elements of our strategy for achieving this goal include:

Capitalizing on Opportunities in the Defense Market. We expect that the current geopolitical climate, terrorist threats and heightened risk of international conflict will continue to drive demand for our defense products. Our defense marketing and sales efforts will emphasize sales of ceramic armor and missile radomes (nose cones) to the U.S. government and, with the authorization of the U.S. government, to foreign allies of the United States. We intend to expand our lightweight ceramic armor products to address new applications in military boats, vehicles and aircraft.

Investing to Improve our Gross Margins and Manufacturing Efficiencies. We will continue to implement lean manufacturing initiatives such as Demand Flow® Technology to reduce inventories and queue times and to increase productivity in order to improve gross profit margins. We intend to expand our in-line production efficiency by using automation and dedicated work cells. We anticipate that as we increase production volumes, we will further implement productivity-enhancing automation.

We are currently renovating, and plan to relocate some of our high energy-utilization manufacturing processes to a 115,000 square foot building that we recently purchased near our Lexington, Kentucky facility where, in addition to other benefits, electricity costs, which are a material part of our cost of product sales, can be reduced significantly. We intend to establish strategic manufacturing relationships in certain international markets, including joint ventures or acquisitions, particularly in low cost manufacturing areas such as Mexico and China. We plan to develop strategic relationships with other manufacturing companies or key customers whose expertise or financial resources can assist us in accomplishing our

objectives.

Identifying New Products and Markets. We intend to identify new products and markets to meet evolving customer requirements for high performance materials. Often our customers may have a materials problem, or need, and may not be familiar or comfortable with the advantages of our advanced technical ceramics. We are committed to educating our current and potential customers and assisting them in developing new technical ceramic components for existing or new products and applications. We seek to educate our customers through technical paper presentations and product literature, by participating in technical or trade show meetings and exhibitions and by maintaining a highly qualified technical sales and marketing staff.

Continuing to Diversify our Non-Defense Revenue Base. We currently depend on the U.S. government for a substantial portion of our revenues. We will continue to grow our customer base, primarily through promoting existing products to new customers and developing new products for new and existing customers. We intend to further diversify our customer product and market base by converting certain advanced technical ceramics, originally developed for defense applications, to industrial and commercial applications.

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Leveraging our Facilities and Technologies to Address New Products and Markets. Over the past two decades, we have designed, constructed and refined a substantial array of highly specialized and customized facilities and equipment for the manufacture of a series of advanced technical ceramics. In conjunction with these manufacturing facilities, we have designed equipment and developed processes that we believe allows us to enter new markets. We intend to leverage our equipment and technology to rapidly respond to new product and market opportunities as we identify them.

Increasing our Export Sales. In recent years we established sales offices in China and England, in addition to commissioned sales representatives in Italy, Germany, Israel, Japan, South Korea, Taiwan and Scandinavia to allow us to better market our products outside the United States. Furthermore, we intend to leverage our existing customer relationships by marketing our products to foreign companies which are affiliated with U.S. companies with whom we are currently doing business. To accomplish each of these goals, we intend to continue to participate in trade shows outside the United States and to further train our export sales and marketing group (both direct employees and independent manufacturing representatives) through training sessions and annual corporate meetings.

Market Applications and Products

Our products are sold into four principal markets: defense, industrial, automotive/diesel and commercial. The following is a description of our principal products by market application:

Defense

Lightweight Ceramic Armor. We have developed and currently manufacture lightweight ceramic armor capable of protecting against threats as great as 12.7mm armor piercing machine gun bullets. Compared to traditional steel armor plates, our ceramic armor systems offer weight savings as great as 40%. Using hot pressed Ceralloy® ceramic, our armor plates are laminated with either Kevlar™, Spectra Shield™, fiberglass, zylon or custom hybrid laminates and formed into a wide variety of shapes, structures and components. Initially, our manufactured ceramic armor was used principally for military helicopter crew seats and airframe panels. We are now also a major supplier of lightweight ceramic body armor for the U.S. military, and we believe we are a leading producer of lightweight ceramic armor for military helicopters. We are also developing products to address similar ballistic protection needs in boats, aircraft and other vehicles.

Missile Radomes (Nose Cones). We manufacture conical shaped, precision machined ceramic radomes which are designed for the front end of defensive missiles. These radomes are used where missile velocities are high and operating environments are severe, and the thermal shock and erosion resistance, high strength and microwave transparency properties of advanced technical ceramics are required. We expect that our ceramic radomes will be used on the PAC-3 (Patriot Advanced Capability) and the Arrow Missile.

Industrial

Industrial Wear Components. Our industrial wear components are made primarily of our Ceralloy® 147 sintered reaction bonded silicon nitride (SRBSN). These SRBSN ceramic components are generally incorporated in high wear areas of industrial machinery where severe abrasive conditions would otherwise wear out vital components. Our wear resistant parts are used to replace parts made of materials such as tungsten carbide or ceramics such as aluminum oxide. Applications include paper making equipment, abrasive blasting nozzles, metal cutting tool inserts as well as custom products.

Semiconductor Equipment Components. The advanced equipment used to process silicon wafers creates harsh process environments that limit the life of traditional ceramic and metal components and produce particulate contamination that lowers wafer yields. We offer the industry advanced technical ceramics that have exceptional corrosion resistance, high thermal conductivity and other key properties that are essential to the manufacture of high quality semiconductors at acceptable yields.

Tempered Glass Furnace Components and Metallurgical and Industrial Tooling. Fused silica ceramic does not, to any material extent, expand when heated or contract when cooled. This material is therefore used for industrial tooling components and molds where complicated shapes and dimensions are maintained over a wide range of temperatures. Such applications include forming and shaping titanium metal used in aircraft manufacture. Other applications take advantage of fused silica's excellent thermal shock resistance and inertness when in contact with glass. We produce fused silica ceramic rollers up to 14 feet in length used in glass tempering furnaces.

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Ceramic-Impregnated Dispenser Cathodes. We manufacture ceramic-impregnated dispenser cathodes for microwave tubes used in radar, satellite communications, electronic countermeasures and other applications. Dispenser cathodes, when heated, provide the stream of electrons which are magnetically focused into an electron beam. Microwave dispenser cathodes are primarily composed of a porous tungsten matrix impregnated with ceramic oxide compounds. The use of ceramic-impregnated cathodes reduces the amount of energy necessary to create a high level of electron emissions. Our ceramic-impregnated cathodes are also used in ion lasers and cathode ray tubes.

Samarium Cobalt Permanent Magnets. We manufacture and market our samarium cobalt magnets as components primarily for microwave tube applications. Electron beams in microwave tubes generated by the dispenser cathodes described above can be controlled by the magnetic force provided by these powerful permanent magnets. The magnets are generally small sub-components of microwave traveling wave tubes.

Precision Ceramics. We manufacture a variety of hot pressed Ceralloy® ceramic compositions that are precision diamond ground to exacting tolerances, primarily for microwave tube applications. The interior cavities of microwave tubes often require microwave absorbing ceramic components capable of operating at elevated temperatures and in high vacuums.

Fused Silica Ceramic Crucibles. We manufacture fused silica ceramic crucibles, or receptacles, which are used in the fabrication of polycrystal silicon for photovoltaic cells that convert sunlight into electricity. These crucibles are designed to withstand high temperatures and thermal shock when in contact with molten silicon, without contaminating the melt.

Automotive/Diesel

Diesel Engine Components. We have been manufacturing ceramic cam rollers for heavy-duty diesel engines since 1999, and now have production contracts to supply cam rollers to two major engine companies. We also have a supply contract with a fuel systems manufacturer for components for a diesel fuel pump. In addition, we are engaged in development projects with a number of other diesel engine and fuel systems manufacturers worldwide for various ceramic components.

Ceramic Armor System Components for Civilian Vehicles. We have been selected by Ford Motor Company to manufacture and supply lightweight ceramic armor system components for incorporation into the Lincoln Town Car Ballistic Protection Series (BPS). Our components will incorporate technology and ballistic protection similar to that which we developed for several defense related applications. This product has been in development for the past two years and was introduced in January 2003. Ford is expected to release the vehicle for sale in the second quarter of 2004.

Commercial

Ceramic Orthodontic Brackets. In orthodontics, to correct a patient's tooth alignment, a small stainless steel bracket is attached to each tooth. These brackets provide a guide to the archwire, which is the wire that sets into each bracket. The cosmetic appearance of this metal is often considered unattractive. Together with 3M Unitek, we have developed a patented ceramic bracket which 3M Unitek markets to orthodontists under the brand name Clarity™. The translucency of this ceramic bracket, together with the classic ceramic properties of hardness, chemical inertness and imperviousness, result in a cosmetic substitute for traditional stainless steel brackets. These brackets reveal the natural color of the patient's teeth while performing the structural functions of traditional stainless steel brackets.

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Operating Divisions and Facilities

We serve our markets from manufacturing facilities in three locations across the United States. The following table includes a summary of our facilities and manufacturing structure.

FACILITY LOCATION	PRODUCTS
Ceradyne Advanced Ceramic Operations Costa Mesa and Irvine, California Approximately 126,000 square feet Lexington, Kentucky[1]	*Defense Applications:* • Lightweight ceramic armor *Industrial Applications:* • Ceralloy® 147 SRBSN wear parts • Semiconductor equipment components • Precision ceramics *Automotive/Diesel Applications:* • Ceralloy® 147 SRBSN automotive/diesel engine parts • Ceramic armor system components for civilian vehicles *Commercial Applications:* • Ceramic orthodontic brackets
Ceradyne Semicon Associates Lexington, Kentucky Approximately 35,000 square feet	*Industrial Applications:* • Ceramic-impregnated dispenser cathodes for microwave tubes, lasers and cathode ray tubes • Samarium cobalt magnets
Ceradyne Thermo Materials Scottdale and Clarkston, Georgia Approximately 135,000 square feet	*Defense Applications:* • Missile radomes (nose cones) *Industrial Applications:* • Glass tempering rolls • Metallurgical tooling • Castable and other fused silica products • Crucibles for photovoltaic solar cell applications

(1) We are in the process of renovating and retrofitting a 115,000 square foot building in Lexington, Kentucky that we purchased in October 2003. We anticipate that it will be put into service in April 2004.

The financial information for all segments is presented within footnote 6 in our consolidated financial statements included in this report.

Sales, Marketing and Customers

Each of our three manufacturing locations maintains an autonomous sales and marketing force promoting its individual products. As of December 31, 2003, we had 15 employees directly involved in sales and marketing, including a marketing manager located in England, and a sales manager located in China.

We also have agreements with manufacturers' representatives in foreign countries who are compensated as a percent of sales in their territory. We are focusing much of our marketing effort outside the United States through direct involvement of senior management personnel from our U.S. facilities. Revenues from export sales represented approximately 5.4% of our net sales in 2003, 10.9% in 2002 and 15.9% in 2001.

We continue to explore various domestic, international and other relationships to increase our sales and market penetration. We seek long-term relationships such as multi-year agreements or exclusive relationships with our customers to promote a smoother, more predictable flow of orders and shipments.

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We sell products and components to the U.S. government and government agencies, as well as to government contractors, original equipment manufacturers and to end users. The U.S. government and government agencies collectively represented approximately 53.7% of our net sales in 2003, 35.9% in 2002 and 17.0% in 2001.

We sell our translucent ceramic orthodontic brackets only to 3M Unitek under an exclusive agreement. Sales to 3M Unitek represented approximately 8.9% of our net sales in 2003, 11.5% in 2002 and 17.6% in 2001. In March 1986, we entered into a joint development and supply agreement with 3M Unitek for the development of a translucent ceramic bracket for orthodontic appliances, commonly known as braces. 3M Unitek is a major manufacturer of stainless steel orthodontic brackets and, early in our relationship, shared with us the functional specifications and properties which ceramic brackets would be required to satisfy. With this information and our experience with translucent ceramics in defense applications, we developed, and in 1987 began manufacturing, translucent ceramic brackets. 3M Unitek may or may not continue to actively market our ceramic orthodontic brackets, and our agreement with 3M Unitek does not require it to maintain any level of commitment to our products.

Manufacturing

We employ a number of advanced technical ceramics manufacturing processes that enable us to deliver high quality products designed to meet specific customer requirements. These processes are described below.

Hot Pressing. Our hot pressing process is generally used to fabricate ceramic shapes for lightweight ceramic armor and semiconductor equipment components. We have designed and constructed induction heated furnaces capable of operating at temperatures exceeding 4,000°F in inert atmospheres at pressures up to 5,000 pounds per square inch. With this equipment, we can fabricate parts more than 26 inches in diameter, which is considered large for advanced technical ceramics. Using multiple cavity dies and special tooling, we can produce a number of parts in one furnace during a single heating and pressing cycle.

Our raw materials are fine powders procured from several outside suppliers. After we process them, the powders are either loaded directly into the hot pressing molds or are shaped into pre-forms prior to loading into the hot pressing molds. The powders are placed in specially prepared graphite tooling, most of which we machine to shape. Heat and pressure are gradually applied to the desired level, carefully maintained and finally reduced. The furnace is removed from the press while cooling to permit the press to be used with another furnace. For most products, this cycle takes approximately 20 hours. The resultant ceramic product generally has mechanical, chemical and electrical properties of a quality approaching theoretical limits. Almost all products, other than armor, are then finished by diamond grinding to meet precise dimensional specifications.

Sintering and Reaction Bonding of Silicon Nitride. The sintering of reaction bonded silicon nitride results in our Ceralloy® 147 SRBSN, which is used in industrial and automotive/diesel applications. This SRBSN process begins with relatively inexpensive high purity elemental silicon (Si) powders, which contrasts sharply with most other competitors' manufacturing techniques which start with relatively more expensive silicon nitride (Si_3N_4) powders.

After additives are incorporated by milling and spray drying, the silicon powders are formed into shapes through conventional ceramic processing such as dry pressing. These shapes are then fired in a nitrogen atmosphere which converts the silicon part to a silicon nitride part. At this step (reaction bonding), the silicon nitride is pressure sintered in an inert atmosphere increasing the strength of the component threefold. As a result of SRBSN processing, the ceramic crystals grow in an intertwining "needle-like" fashion which we have named NeedleLok™. The NeedleLok™ structure results in a tough, high fracture energy part. This process is relatively economical due to the low cost of the starting powders and can be used to produce extremely high production volumes of parts due to the use of conventional pressing processes.

Fabrication of Translucent Ceramics (Transtar®). We produce translucent aluminum oxide (Transtar®) components primarily for use as orthodontic ceramic brackets. We purchase the high purity powders from outside vendors and process them using dedicated conventional ceramic mechanical dry presses. The formed blanks are then fired in a segregated furnace in a hydrogen atmosphere at over 3,000°F until the ceramics enter into a mechanically strong, translucent condition. These fired aesthetic brackets then have certain critical features diamond ground into them. The next step is a proprietary treatment of the bonding side in order to permit a sound mechanical seal when bound to the patient's teeth. In the final step we furnace braze a stainless steel channel into each archwire slot which has been previously diamond ground into the bracket.

Diamond Grinding. Many of our advanced technical ceramic products must be finished by diamond grinding because of their extreme hardness. Our finished components typically are machined to tolerances of ±.001 inch and

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occasionally are machined to tolerances up to ±.0001 inch. To a limited extent, we also perform diamond grinding services for customers independently of our other manufacturing processes to specifications provided by the customer. Our diamond grinding facilities can perform surface grinding, diameter grinding, ultrasonic diamond grinding, diamond lapping, diamond slicing and honing. The equipment includes manual, automatic and computer numerically controlled (CNC) grinders. We have specially adapted the CNC grinders for p